

- 5 The invention relates to a vehicle comprising
- an internal combustion engine;
 - a generator adapted to be driven by the internal combustion engine;
 - at least one drive electromotor; and
 - 10 - a rotational energy storage for covering peak requirements.

15 A vehicle of this type is known from Document DE-A-24 36 546. In the known vehicle, the internal combustion engine is mechanically coupled to the drive electromotor and to the rotational energy storage; the rotational energy storage and the generator are also mechanically coupled. Energy is supplied to or withdrawn from the rotational energy storage solely in the form of mechanical rotational energy.

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- In comparison therewith, the vehicle according to the invention is characterized in
- 25 a) that the rotational energy storage is constructed such that its speed can be increased by supply of electrical energy and decreased by withdrawal of electrical energy;
 - b) that the rotational energy storage is electrically connected to the generator and the at least one drive electromotor; and in
 - 30 c) that the drive electromotor and/or the rotational energy storage each comprises:
 - a stator provided with current conductors and a rotor provided with permanent magnets, said

stator and said rotor being disposed with a gap distance therebetween,

- at least one sensor provided on the stator and detecting the relative position of stator and rotor,
- an electronic switching means which is controlled by the sensor and which in a drive-effective or generator-effective relative position of stator and rotor establishes an electrical connection between the current conductors and a current source or current sink, respectively.

Electromotors having the features listed hereinbefore under item c) are known per se (e.g. DE-A-16 13 758).

For the sake of brevity, the term "drive" will be used in the following instead of "drive electromotor".

The electronic switching means controlled by the sensor automatically takes care that, in appropriate relative positions of stator and rotor, current is supplied to the conductors or withdrawn from the conductors. The conductors in most cases are provided in the form of coils and windings.

The terms "stator" and "rotor" as used are not intended to mean that the stator necessarily is the stationary part of the drive or generator and the rotor necessarily the moving part of the drive or generator. Rather, both possibilities are feasible, i.e. moving stator with non-moving rotor and non-moving stator with moving rotor, and even the possibility that both stator and rotor move at different speeds. However, the case of the non-moving stator is pre-

ferred, since current must be supplied thereto and withdrawn therefrom, respectively.

5 A development of the invention is characterized in that the portion of the rotor, to which the sensor is responsive, is slidable with respect to the permanent magnets or the sensor is slidable with respect to the stator in the direction of relative movement of stator and rotor. This provides a simple possibility of modifying the normal drive or generator function, for
10 example to change the speed of the drive, to switch off the drive or generator, to switch over from drive function to generator function and vice versa, or to reverse the direction of the drive or the current direction of the current supplied from the generator,
15 respectively.

Preferably, a sensor is used that is responsive to the permanent magnets provided anyway in terms of function, or to permanent magnets provided specifically
20 for this purpose. In particular in the case mentioned first, this leads to a drive or generator of simple construction. Particularly preferred types of sensors are Hall probes, reed contacts, photocells, ultrasonic
25 sensors, gas flow sensors, induction sensors or permeability sensors.

In the drive according to the invention, a speed reduction is already immanent by the counter e.m.f. induced in the current conductors, and a thrust reduction is already immanent by the supply frequency and the inductance of the current conductors. However, speed and/or thrust are preferably limited electronically.
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The electronic switching means may have a power control means for controlling the electrical power supplied to the current conductors or withdrawn therefrom, said power control means being preferably a pulse width control circuit, a phase control circuit, an intermediate clock circuit or a direct converter circuit. Preferred controllable semiconductor switches are thyristors, in particular such thyristors that can be switched both on and off via the gate electrode with little control power, as well as triacs.

Because of numerous advantages it is particularly preferred to divide the stator into several sections each having a switching means associated therewith. Preferably, at least one sensor is provided for each stator section. Since the particular switching means has to manage smaller currents or powers for each section, it is possible to make do with switching means of lower power, whereby the price thereof decreases quite considerably beyond proportion. This is accompanied by a reduction of the cooling expenditure for the switching means, an increase in the redundancy or reliability, since the failure of individual sections will not impair the overall function, as well as a simplification of the maintenance by replacement of comparatively inexpensive individual switching means. Finally, one reaches as a whole also a lower voltage range, since the counter e.m.f. per section remains low and since one can thus remain in the *VDE class up to 1000 V which is advantageous in terms of insulation expenditure and thus in terms of cost expenditure.

Translator's Note: "VDE" is a German abbreviation for "Verband Deutscher Elektrotechniker", meaning in English translation: association of German electrical engineers.

Thus, seen all in all, it is much more advantageous to use, instead of one single or only few sections each with a switching means, an increased number of sections and switching means and to provide therefor a larger number of switching means which, however, have a lower individual switching power. In the lower boundary case, a stator section consists of one single current conductor pair or one single coil, respectively.

It may be provided that the current conductor wiring can be altered from series connection to parallel connection and vice versa.

A particularly preferred embodiment of the drive or generator according to the invention is characterized in that the rotor pole pitch, measured as centre-to-centre spacing of a pair of adjacent permanent magnets, and the stator pole pitch, measured as centre-to-centre spacing of a stator pole pair cooperating with the permanent magnet pair in the form of a magnetic circuit, are different, and in that the stator pole pairs can be switched individually or in groups having corresponding functional relative positions relative to permanent magnet pairs. Safe starting is achieved in this manner, since there is no relative position of stator and rotor in which no thrust is produced despite of the current conductors being switched on. Due to the different pole pitches of stator and rotor, individual switching on of the current conductors for the individual stator poles or stator pairs is achieved. When drive-effective or generator-effective relative positions are present at several locations of the stator across the length of the rotor, these locations may be switched simultaneously.

Preferably, the stator poles are provided along the direction of relative movement of stator and rotor at such a distance that, upon further movement of the rotor by substantially (the term "substantially" is inserted in order to take account of the cases of different pole pitches of stator and rotor) one rotor pole pitch, the next magnetic circuit relative position is reached. This so-called one-phase design has in particular the advantage that the arrangement of the current conductors or coils on the stator is easier, and especially that so-called winding heads with crossing current conductors are avoided; the provision of the stator with the current conductors is thereby easier as regards assembly thereof.

The stator preferably has one to four stator poles more or less than the rotor over a length corresponding to the rotor length.

It is possible furthermore to provide the conductor wiring on the stator in such a manner that it can be altered from series connection to parallel connection and vice versa. This provides quite a number of possibilities of influencing the speed, the power and the frequency taken-out in the drive or generator according to the invention.

The current conductors preferably can be short-circuited for braking.

Preferably, the respective electronic switching means for controlling a drive electromotor has an additional electronic means for preventing an excessive difference between the circumferential speed of the wheel driven by the particular electromotor and the moving speed of the vehicle. In particular by limiting the

circumferential speed of the drive wheel it is possible thereby to prevent spinning of the drive wheels in electronic manner or to achieve an effect similar to a differential lock also for several drive
5 wheels of one axle.

Multi-wheel drive or all-wheel drive can be realized in simplest manner in the invention.

10 As regards drive, torque, speed and the like, the drive or generator according to the invention allows good regulation within wide ranges with comparatively little expenditure.

15 The rotational energy storage can be fed with electrical power which is then stored mechanically as rotational energy, and electrical energy can be withdrawn from the rotational energy storage. As a consequence of the electronic control, there is largely freedom as
20 regards the supplied and withdrawn current intensity and frequency.

The expression "drive or generator" was often used hereinbefore also when the drive function was in the
25 foreground. This is intended to emphasize that drives may also be provided with a possibility of switching over to generator function for the purpose of braking.

The invention preferably makes use of highly coercive
30 permanent magnets of an element of the group of the rare earths, particularly samarium, and cobalt. Such magnets permit the provision of relatively large gap widths. Moreover, they distinguish themselves by a virtually straight characteristic line in the fourth
35 quadrant, so that they are relatively insensitive to

gap width changes and opposing fields, for instance due to electromagnets.

It is pointed out that the at least one drive electro-
motor provided in the vehicle according to the inven-
tion need not necessarily be integrated in a vehicle
wheel as elucidated in a following embodiment. Rather,
the drive electromotor may also be disposed in usual
manner beside the respective vehicle wheel.

The invention will now be elucidated in more detail on
the basis of embodiments shown schematically in the
drawings in which

Figs. 1 to 4 show embodiments of rotational drives or
generators illustrating several basic con-
figuration possibilities;

Fig. 5 shows a drive integrated in a vehicle
wheel;

Fig. 6 shows a vertical axial sectional view of a
flywheel storage;

Fig. 7 shows a cross-sectional view of a rotary
drive or generator.

Figs. 1 to 4 show some basic configurations of rotary
drives or generators according to the principle of
the invention. The part of each drive or generator
shown on the right-hand side in these figures is rota-
tably supported by bearings 50 and forms the rotor or
movable part. In the embodiment according to Fig. 1,
the rotor portion proper is substantially cup-shaped,
with the inner circumference of the cup having perma-
nent magnets 30 of alternating polarity distributed

thereon in annular manner. The stator 2 has the shape of a drum or roller having a lamellar structure on its outer circumference, with the individual lamellae being axially packed against each other. The stator 2 carries on its outer circumference axially extending current conductors, not shown in the drawings, in a suitable pitch. The portion of the rotor 32 having the permanent magnets 30 secured thereto consists of ferromagnetic material so as to provide a return path. The current conductors may be placed for example in axially extending grooves of the stator.

The stator 2 carries on its outer circumference a Hall probe or several annularly distributed Hall probes 38 cooperating with the permanent magnets 30. As soon as it is detected on the side of the Hall probes that a part on the rotor side and a part on the stator side of one or several magnetic circuits are located in a drive-effective or generator-effective relative position, the current conductor or coil of this circuit or the current conductors or coils of these circuits, respectively, are switched on automatically.

The stator ring may be switched in total by one single switching means or may be divided into several sections each having a switching means, with one current conductor pair or coil constituting the lower limit case of a section. There may be provided further features of the electronic control disclosed in this application.

The embodiment according to Fig. 2 differs from the embodiment according to Fig. 1 in that the stator portion disposed radially within the ring of permanent magnets 30 projects into the rotor in cup-shaped manner and in that, radially within this stator

portion, there is provided an annular projection 52 of the rotor 32 so as to leave free a slight air gap to the stator ring. In this manner the part of the magnetic circuits that was previously taken by the stator 2 has been displaced primarily to the annular projection 52 rotating at the same speed as the permanent magnets 30. The eddy current losses can be reduced thereby. The stator portion located radially between the permanent magnets 30 and the annular projection 52 can also be designed in the form of so-called air current conductors or air coils or in the form of current conductors or coils whose interstices are filled with a casting compound of the type described hereinbefore, in such a manner that the conductor surfaces located on the outer circumference and on the inner circumference are left free.

The embodiment according to Fig. 3 differs from the embodiment according to Fig. 1 in that the rotor 32 is designed as a disc and that the permanent magnets are arranged in annularly distributed manner on the axial face side of the disc facing away from the bearings 50. The stator 2 is also disc-shaped and carries the lamella pack and the not shown current conductors on its face side facing the rotor 32. The individual circumferentially extending lamellae of the lamella pack are provided radially adjacent each other.

The embodiment according to Fig. 4 differs from the embodiment according to Fig. 3 in that the rotor 32 comprises two discs which are connected to each other on the outer circumference and between which the stator is disposed which is designed as a disc. On the disc of the rotor 32 facing away from the bearings 50, it is possible either to provide a concomitantly rotating magnetic return path according to the principle

of the embodiment of Fig. 2, or it is possible, as shown in the drawing, to arrange there a number of annularly distributed permanent magnets 30 on the face side. In the latter case, the stator disc thus co-
5 operates on both face sides with permanent magnets 30, so that a compensation of the axially acting magnetic forces of attraction results. The embodiment according to Fig. 4 may be extended by the addition of further stator discs and rotor discs. The stator portion
10 between the two rotor discs provided with permanent magnets 30 may be realized, as described in the embodiment according to Fig. 2, with air current conductors or air coils or with conductors or coils filled with casting compound.

15 In the embodiments according to Figs. 1 to 4, the centre-to-centre spacings of the current conductors of the stator 2 and, respectively, the centre-to-centre spacings of the permanent magnets 30 are substantially
20 matched to each other, each in circumferential direction, for ensuring the drive or generator function, respectively.

The embodiment according to Fig. 5 shows the wheel rim
25 56 of a motor vehicle equipped with a tyre 54. The wheel rim 56 is threadedly attached to the face side of a wheel hub 58. The hub 58 is supported on a hollow axle stub 62 with the aid of two rolling bearings 60. The hub 58 may also be provided in the form of a brake
30 drum.

The wheel rim 56 has on the whole an approx. dish- or bowl-shaped configuration, with the edge of the dish extending, over a width of several centimetres, approximately axially parallel to the axis of rotation of
35 the wheel rim 56. At said edge, a number of permanent

magnets 30 is disposed along the inner circumference in annularly distributed manner. A substantially disc-shaped stator 2 is threadedly attached to the free face side of the axle stub 62, said stator 2 being axially expanded at the outer circumference and being of lamellar structure as described in more detail in conjunction with the embodiment according to Fig. 1. A drive 4 or a generator operative during braking of the vehicle is thus formed in this constructionally extremely simple manner. The electronic control takes place as described in more detail in connection with the embodiment according to Fig. 1 and may comprise additional ones of the features disclosed in this application. The switching means 40 is secured to the outer face side of the stator disc 2. Current supply takes place through the hollow axle stub 62. The as such open, outwardly directed face side of the wheel rim 56 is closed by a wheel cap 46. By removal of the wheel cap 46, the entire drive or generator, in particular the switching means 40, is easily accessible for maintenance work.

Fig. 6 shows a rotational energy storage 6 having a vertical axle 66, with a flywheel 68 being adapted to rotate together therewith. The flywheel is disposed in an evacuated pressure-proof casing 70. The casing 70 consists of a pot- or cup-shaped bottom part 72 and a cover-like top part 74 threaded to the bottom part 72 in sealed manner. The vertical axle 66 is supported both in the bottom part 72 and in the top part 74 with the aid of roller bearings 76 which in turn are received in the respective casing part via resilient intermediate layers 78.

The flywheel 68 comprises a hub 80 connected to the axle 66, a disc-like portion 82 extending outwardly

therefrom, as well as an axially enlarged flywheel mass portion 84. The flywheel mass 84 expediently consists of a specifically heavy material, for example steel, with windings of steel ropes with plastics filling being conceivable as well. As regards the remainder of the flywheel 68, it is possible to use, apart from metal, also plastics materials, in particular fibre-reinforced plastics materials, for example plastics materials reinforced by glass fibres, carbon fibres and the like.

The disc portion 82 carries on its top side a ring 86 of ferromagnetic material. The inner circumference of the ring 86 has a number of permanent magnets 30 of alternating polarity distributed thereon in annular manner. The permanent magnets 30 thus are pressed against the ring 86 by the centrifugal force. Radially within the permanent magnets 30 and so as to leave free an annular gap, a ring of vertical air current conductors 10 or air coils or of conductors or coils filled with casting compound as described hereinbefore, projects downwardly from the cover top part 74. These constitute the functional part of the stator 2. The coils each have two vertical branches interconnected by horizontal branches curved substantially in annular manner. Radially inwardly of the ring of current conductors 10 or coils, a return path ring 88 is supported by the disc portion 82 so as to leave free an annular gap to said current conductors 10. A drive and generator is formed in this manner which in principle has the construction of the embodiment according to Fig. 2, however with a vertical axis of rotation.

The electronic control takes place in the manner as elucidated in more detail by way of the embodiment

according to Fig. 1 and may comprise further features disclosed in the present application.

5 It is possible to provide so-to-speak two electronic controls, namely one for the "drive function" = speed increase of the flywheel 68 by supplying electrical energy thereto, and one for the "generator function" = speed decrease of the flywheel 68 by removal of electrical energy. It is thus possible to supply electrical energy in synchronism with the respective speed of the flywheel 68 and to withdraw from the flywheel storage 6 electrical energy at a frequency which is not necessarily in a fixed relationship to the flywheel speed. However, for many purposes it may also be sufficient to simply withdraw the electrical energy at the particular frequency present at that time, without electronic control, and to rectify for example the alternating current delivered. The design preferably is such that the stator 2 contains two separate current conductor systems, namely one for current supply and one for current withdrawal. With such a design, it is possible to simultaneously supply electrical energy to the flywheel storage 6 and to withdraw electrical energy therefrom, in which the frequencies of the supply current and the withdrawal current may be different from each other. Moreover, it is possible to purposefully design the current conductor systems for the supply and withdrawal functions, for example especially low-ohmic withdrawal windings for a brief withdrawal of currents with high current intensity. In case of high speeds of the flywheel 68, it is advisable to provide the current conductors in a manner so as to be suited for high frequencies, in order to avoid a skin effect.

The vertical support of the flywheel 68 is made by means of repulsive permanent magnets. To this end, a plurality of permanent magnets 90 is disposed on the floor of the casing bottom part 72 in annularly distributed manner. Opposite these permanent magnets 90, there is a plurality of annularly distributed permanent magnets 92 on the lower face of hub 80. It is also possible to support the weight of the flywheel 68 by attracting permanent magnets. It is possible to provide by way of the permanent magnet support a precession balance with respect to the precession of the rotation of the earth. Instead of the radial support by means of rolling bearings, it is also possible to provide a support with the aid of electromagnets which are variable in their magnetic force.

The radial support is preferably made in supercritical manner as regards possible radial oscillations.

It is possible to design the axle 66 as a hollow axle and to provide therethrough a pressure support between the casing bottom part 72 and the casing top part 74.

In particular when the flywheel 68 is of less axial height than depicted in Fig. 6, the casing bottom part 72 and the casing top part 74 may be constituted by comparatively inexpensive round members from the field of autoclave construction, having a substantially dish-shaped configuration.

Fig. 7 shows a rotary drive 4 constructed according to the basic principle described in Fig. 1, but having the rotor disposed radially inside of the stator. The altogether cylindrical stator 2 consists of an axially assembled pack of - roughly speaking - annular sheets of ferromagnetic material. The stator 2 has inwardly

projecting stator teeth 3 distributed across the inner circumference thereof. Each stator tooth 3 includes three coils 10 disposed in radially successive manner. Each coil 10 consists of two axial branches and two
5 face-side branches connecting the axial branches. Each coil is wound of several wires that are insulated with respect to each other, which, however, is shown in Fig. 7 in the form of one single thick wire.

10 The rotor 31 rotating within the stator 2 carries on its outer circumference a number of permanent magnets 30 of alternating polarity, which are provided in an even number, distributed in a ring arrangement and extend in axial direction. For reasons that will
15 become clearer in the following, the mutually identical distances between the stator teeth 3, as measured from centre to centre in circumferential direction, are smaller than the analogously measured centre-to-centre distances between the permanent magnets 30 in
20 such a manner that there are provided one or two pole teeth 3 more than permanent magnets 30.

On each pole tooth 3 there is provided a Hall probe 38 which is response to the permanent magnets 30, both to
25 north poles and to south poles. When the Hall probe 38 detects a drive-effective relative position between a permanent magnet 30 and the stator tooth 3 associated with this Hall probe 38, one, two or all three coils 10 of this stator tooth 3 are switched on. The
30 switching means indicated by reference numeral 40 may operate, for example, in accordance with the principles as elucidated in more detail in a preceding embodiment, however, modified to one-phase design, which even simplifies the construction. However, what
35 is novel in the present embodiment is that it is possible with the aid of a control member 114 to exert

influence as to whether all three coils 10 of the stator tooth 3 concerned are switched on or only two coils 10 or only one coil 10. When a high torque is demanded from the motor 4, all three coils 10 are
5 switched on, and with a lower torque demand fewer coils 10 are switched on. The control unit 114 may additionally have the function of switching the individual coils 10 of each stator tooth 3 from a parallel connection to a series connection, and vice versa.
10 This can also be effected in the possibility of simultaneous switching several coils at different circumferential locations, as described hereinafter. The series connection is recommendable at low speed and high torque, and the parallel connection is recommendable at high speed and low torque.
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To switch on each coil 10 of each stator tooth 3 via a separate switching means 40 may be performed on the one hand for the reason of reducing the switching
20 power, which produces the advantages described in the introductory part of the specification. On the other hand, the slightly different pole pitch of stator 2 and rotor 32 provides the advantage of safe starting, more uniform motor run and more uniform loading of the
25 mains.

The coils 10 of each stator tooth 3 are switched on with differing current directions, depending on whether a north pole of a permanent magnet 30 or a
30 south pole of a permanent magnet 30 is located opposite the stator tooth 3. This is controlled by the switching means 40.

In practical operation there are always coils 10 of
35 several adjacent stator teeth 3 switched on. When the pole pitch difference between stator 2 and rotor 32 is

relatively small, even coils 10 of almost all stator teeth are switched on simultaneously. The coils of circumferentially adjacent stator teeth 3 are acted upon with different current directions, as indicated in Fig. 7.

In the embodiment according to Fig. 7, the so-called one-phase design is realized: when two circumferentially adjacent permanent magnets 30 are located opposite two stator teeth 3, there is no further stator tooth between these two stator teeth 3. Due to the one-phase design there are no so-called winding heads present on the axial face sides of the stator 2, on which the current conductors of the various phases would cross in case of a multi-phase design. Rather, the coils 10 of mutually alike design can simply be placed onto the stator teeth 3. However, it is also possible to modify the embodiment according to Fig. 7 towards a multi-phase design.

Furthermore, express reference is made to the fact that the embodiment according to fig. 7 may also be modified to the effect that there is no radially stacked pack of several coils 10 provided for each stator tooth 3, but for example only one coil 10.

When two stator teeth 3 more than permanent magnet poles are provided across the circumference, an identical relative position of permanent magnet poles and stator tooth poles always occurs simultaneously at two locations on the circumference of the motor 4. The coils of these two locations may be switched simultaneously by one single switching means 40. The same applies analogously for greater differences in the number of the stator teeth 3 and the permanent magnets 30.

Instead of one single Hall probe 38 that is responsive both to magnetic north poles and to magnetic south poles, it is also possible to provide two Hall probes axially beside one another, with one thereof being responsive to north poles only and the other one being responsive to south poles only.

The embodiment according to Fig. 7 may also be modified to the effect that the permanent magnets 30 are mounted on the inner circumference of a substantially cylindrical casing-like part and the stator teeth 3 on the outer circumference of a part rotating inside thereof, so that the stator 2 rotates while the rotor 32 is stationary. This has indeed a certain disadvantage that the supply or withdrawal of electrical energy must be made to and from a rotating part, respectively. However, on the other hand, the attachment of the permanent magnets 30 is no longer subject to the centrifugal force, which constitutes a quite considerable advantage especially with larger permanent magnets 30. Furthermore, the air gap between the permanent magnets 30 and the pole areas of the stator teeth 3 is shifted further outwardly with a given outer diameter of the apparatus, since the permanent magnets 30 need radially less space than the stator 2. Due to the fact that the magnetic circumferential force acts on a larger radius, a higher torque of the motor 4 is thus created.



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Patent Claims

1. A vehicle comprising

- an internal combustion engine;
- a generator (4) adapted to be driven by the
- at least one drive electromotor (4); and
- a rotational energy storage (6) for covering

characterized in

a) that the rotational energy storage (6) is constructed such that its speed can be increased by supply of electrical energy and decreased by withdrawal of electrical energy;

b) that the rotational energy storage (6) is electrically connected to the generator (4) and the at least one drive electromotor (4); and in

c) that the drive electromotor (4) and/or the rotational energy storage (6) each comprises:

- a stator (2) provided with current conductors (10) and a rotor (32) provided with permanent magnets (30), said stator and said rotor being disposed with a gap distance therebetween,

- at least one sensor (38) provided on the stator (2) and detecting the relative position of stator (2) and rotor (32),

- an electronic switching means (40) which is controlled by the sensor (38) and which in a drive-effective or generator-effective relative position of stator (2) and



rotor (32) establishes an electrical connection between the current conductors (10) and a current source or current sink, respectively.

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2. A vehicle according to claim 1, characterized in that the portion of the rotor (32), to which the sensor (38) is responsive, is slidable with respect to the permanent magnets (30) or the sensor (38) is slidable with respect to the stator (2) in the direction of relative movement of said stator (2) and said rotor (32).

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3. A vehicle according to claim 1 or 2, characterized in that the sensor (38) is a sensor (38) responsive to control magnets constituted by the permanent magnets (30) or by specific permanent magnets disposed on the slidable portion.

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4. A vehicle according to any one of the preceding claims, characterized in that the switching means (40) is a power control means for controlling the electrical power supplied to the current conductors (10) or withdrawn therefrom.

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5. A vehicle according to claim 4, characterized in that the power control means is a pulse width control circuit, a phase control circuit, an intermediate clock circuit or a direct converter circuit.

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6. A vehicle according to any one of the preceding claims, characterized in that an electronic speed limiting circuit is provided.

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7. A vehicle according to any one of the preceding claims,
characterized in that the stator (2) is divided
5 into a plurality of sections each having a switching means (40) associated therewith.
8. A vehicle according to any one of the preceding claims,
10 characterized in that the current conductor wiring can be altered from series connection to parallel connection and vice versa.
9. A vehicle according to any one of the preceding claims,
15 characterized in that the current conductors (10) can be short-circuited for braking.
10. A vehicle according to any one of the preceding claims,
20 characterized in that the generator (4) has a rotor (32) equipped with permanent magnets (30) disposed preferably on the flywheel of the internal combustion engine.
11. A vehicle according to any one of the preceding claims,
25 characterized in that the drive electromotor (4) and/or the generator (4) is designed in external rotor construction.
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12. A vehicle according to any one of the preceding claims,
35 characterized in that the drive electromotor (4) and/or the generator (4) and/or the rotational energy storage (6) is composed with highly



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coercive permanent magnets (30) of an element of the group of the rare earths, in particular samarium, and cobalt.

5 13. A vehicle according to any one of the preceding claims,

10 characterized in that an electronic means is provided that is adapted to prevent an excessive difference between the circumferential speed of the vehicle wheel driven by the drive electromotor (4) and the moving speed of the vehicle, or an excessive difference in rotational speed of two drive electromotors (4) of one axle of the vehicle.

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14. A vehicle according to any one of the preceding claims,

20 characterized in that the drive electromotor (4) operates as a generator (4) for braking the vehicle.